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In Re Application of:

DAVID H. McMURTRY, ET AL.

Examiner:

Serial No.

Art Unit:

Filed: **HEREWITH**

For: **INTERLEAVED SEQUENCING METHOD FOR
MULTIPLE TWO-DIMENSIONAL SCANNING CODES**

TRANSMITTAL LETTER

Box: Patent Application
Asst. Commissioner of Patents
Washington, D.C. 20231

Dear Sir:

Enclosed herewith for filing in the above-identified case are:

- Specification;
- One (1) sheets of drawings;
- Declaration and Power of Attorney;
- Two (2) Patent Application Assignments with Recordation Cover Sheets;
- Information Disclosure Statement with PTO Form-1449;
- Authorization to Charge IBM CORPORATION
  Deposit Account 09-0466; and
- Our return postcard, which we would appreciate your date stamping and returning to
  us upon receipt.

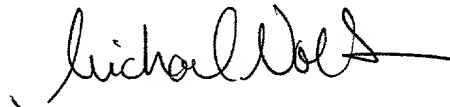| *"EXPRESS MAIL" NO. EL316136185US* |
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The total filing fee has been calculated as follows:

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Five Add'l Dep. Claims (over 20) (5 @ $18.00 each)	=	$ 90.00
2 Assignments (2 @ $40.00 each)	=	$ 80.00
Total filing fee	=	$1,008.00

I hereby authorize the Assistant Commissioner to charge these fees and any additional fees which may be required, or credit any overpayment to IBM CORPORATION Deposit Account No. 09-0466. A duplicate copy of this letter is enclosed.

Respectfully submitted,

Date:____7-27-99____

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INTERLEAVED SEQUENCING METHOD FOR
MULTIPLE TWO-DIMENSIONAL SCANNING CODES

BACKGROUND OF THE INVENTION

Technical Field

This invention relates in general to scanning codes for identifying parts, and in particular to a method for sequencing multiple two-dimensional scanning codes to identify small parts.

Background Art

In the manufacturing of disk drives, it is very important to be able to track spindle motors by their serial number. The serial numbers are used to assure that motors and disks are correctly reworked and ultimately assembled into the disk drive correctly. Some disk drives utilize a flexible printed circuit cable upon which a linear, one-dimensional bar code label can be affixed with pressure sensitive adhesive. The labels contain both human-readable and scanner-readable serial number information.

However, some disk drives use leaf spring connectors
that mate to connector pads on the motors instead of using
flexible cables. These disk drives have very limited
surface area upon which a one-dimensional bar code label may
be affixed. The only readily available surface area on
these disk drives is their ferrofluid cap on top of the
motor. In order to have the serial number encoded, a more
compact two-dimensional (2-D) "micro-checkerboard" code,
such as a "Data Matrix" symbols, is used (see Figure 1).

Although it is possible to locate the 2-D code and
human-readable characters around the cap, it is not
advisable to use adhesives to attach a preprinted label to
the cap since the cap will rotate at high speeds. Small
particles of adhesive could creep out from beneath the
labels and fly off into the file. Also, small shards from
the label cutting operation could fly off the label and
cause contamination failures.

This problem can be overcome by laser etching the 2-D
code and human-readable characters onto the cap. This
solution can be performed with no contamination exposure.
However, with laser etching, the optical contrast and edge
sharpness are somewhat lacking compared to conventionally

printed labels. This is due to the fact that 2-D codes contain many very small cells, some of which are etched and some of which are left blank. For example, the minimum permissible array size is a 10x10 code array containing 100 cells. However, a 10x10 array can only encode up to three alphanumeric characters. In order to maximize the scanner read reliability, it is important to keep the individual cells of the 2-D code as large as possible. Larger cells are more impervious to slight dents, scratches and raw material surface imperfections, and laser etching imperfections than small cells.

Unfortunately, the serial numbers of some disk drives contain nine alphanumeric characters. It would take a 14x14 array to encode the entire nine characters in a single array, which is prohibitively large in size to fit on small parts. As shown in Figure 2, one solution is to split the serial number 11 into three array codes 13, 15, 17 of three characters each on the part 19 (i.e. three 10x10 arrays located adjacent to one another). It is noteworthy that, using the same available space, the cells of a 10x10 array are about twice as large as those of a 14x14 array.

At the beginning of the manufacturing operation, the motor is placed onto a conveyor pallet by an operator without regard to angular orientation. The optical scanner for the 2-D codes views the entire motor cap. The scanner algorithm is capable of reading all three arrays independent of their orientation. However, since there is no predictable angular orientation, the scanner is unable to control the scan sequence. The three arrays must be ordered in the correct sequence so that the nine character serial number can be correctly reconstructed. Thus, a method for assuring the correct sequencing of multiple, randomly read array codes is needed.

Summary of the Invention

A component has three, laser etched, two-dimensional arrays that each contain three characters of its nine character, alphanumeric serial number. In order for this concept to work, the first three characters of the serial number must be constant for all parts of this type. As a result, the serial number can be divided among the arrays by using the first character as the first digit in the first array, the second character as the first digit in the second

array, and the third character as the first digit in the

third array. The remaining characters of the serial number

are interleaved in the arrays in the following pattern: the

fourth and fifth characters are the second and third digits

in the first array, the sixth and seventh characters are the

second and third digits in the second array, and the eighth

and ninth characters are the second and third digits in the

third array. With this system, the correct sequence for the

arrays will always be ascertainable regardless of the order

in which they are read.

Brief Description of the Drawings

So that the manner in which the features, advantages

and objects of the invention, as well as others which will

become apparent, are attained and can be understood in more

detail, more particular description of the invention briefly

summarized above may be had by reference to the embodiment

thereof which is illustrated in the appended drawings, which

drawings form a part of this specification. It is to be

noted, however, that the drawings illustrate only a

preferred embodiment of the invention and is therefore not

to be considered limiting of its scope as the invention may

admit to other equally effective embodiments.

Figure 1 is an enlarged plan view of two-dimensional,

machine-readable code.

Figure 2 is a top view of a part having prior art,

simulated, multiple two-dimensional array codes.

Figure 3 is a top view of the part of Figure 1 having a

simulated sequence of two-dimensional array codes

constructed in accordance with the invention.

Figure 4 is an enlarged top view of the part of Figure

3 having human-readable and machine-readable codes.

Best Mode for Carrying Out the Invention

Referring to Figures 3 and 4, an assembly part such as

a motor cap 21 with a central axis and three, laser etched

array codes 23, 25, 27 on its upper surface for identifying

and encoding the nine character, alphanumeric serial number

of cap 21. A human-readable code 29 of the serial number is

also etched on cap 21. Note that Figure 4 depicts a

realistic view of cap 21 with human and machine-readable

codes, while Figure 3 is shown for illustration purposes.

In the embodiment shown, the array codes 23, 25, 27 are

laser etched on cap 21 and substantially equidistant from
the axis.

Fortunately, for a given product program having a nine
character alphanumeric serial number, the prefix or first
three characters are always constant. The remaining
characters are completely unique to cap 21. Thus, the first
three or "order" characters can be entered into the system
by the operator at the beginning of a production run. Note
that the order characters may also comprise other prefixes,
suffixes, or the like.

For example, if a serial number is "XYZ1A2B3C", it
would normally be split between arrays as follows: "XYZ",
"1A2", and "B3C", respectively (like Figure 2). However, if
the serial number code is interleaved by taking the first
three characters and assigning them as the first digit of
each of the arrays 23, 25, 27, their correct sequence will
always be ascertainable regardless of the order in which
they are read. Thus, the serial number would be split
between arrays 23, 25, 27 as follows: "X1A", "Y2B", and
"Z3C" (Figure 3). The sequence information is encoded into
each array and can be used to reconstruct the correct serial
number independent of the scan sequence. Note that in

Figures 2 and 3, even through the "digits" of the arrays are

shown as alphanumeric characters, they would actually be

encoded in a machine-readable format (like Figure 4). After

cap 21 is encoded, its codes or arrays 23, 25, 27 are

5   scanned or read by a machine code reader to reconstruct its

serial number and verify its accuracy.

The invention has several advantages. This encoding

method permits the use of multiple, two-dimensional codes on

an unoriented axis-symmetric object with normal scanners

which are incapable of determining code sequence. It is

desirable to maintain simplicity with the normal serial

number sequence which increments the low order digits most

often, and the high order digits the least. This concept is

useful to maximize the readability of the serial number in

the presence of dirt, scratches, and contamination. The

serial number is divided amongst a plurality of data matrix

codes to maximize the size of the individual cells in each

matrix.

While the invention has been shown or described in only some of its forms, it should be apparent to those skilled in the art that it is not so limited, but is susceptible to various changes without departing from the scope of the invention. For example, the order characters, unique characters, and array codes could be greater or fewer in number. In addition, the serial number could be sequenced in any programmable order including forward, backward, odds, evens, etc.

We claim:

1.   An apparatus, comprising:

     a body;

     a serial number associated with the body, the serial number having a plurality of order characters and a plurality of unique characters;

     a plurality of machine-readable codes on the body, each encoding a portion of the serial number; and wherein

     a first one of the codes encodes a first one of the order characters, a second one of the codes encodes a second one of the order characters, and the unique characters are divided among and encoded by the codes following said ones of the order characters.

2.   The apparatus of claim 1 wherein the codes are two-dimensional array codes.

3.   The apparatus of claim 1 wherein the serial number is also located on the body in human-readable form.

4.   The apparatus of claim 1 wherein the order characters and the unique characters are independently and sequentially divided among the codes.

5.   The apparatus of claim 1 wherein the body has an axis and the codes are located on the body about the axis.

6.   The apparatus of claim 1 wherein the codes are laser etched on the body.

7.   The apparatus of claim 1 wherein each of the codes comprises a 10x10 array of cells.

8.   The apparatus of claim 1 wherein the serial number has three order characters and six unique characters, and wherein there are three codes on the body, each encoding three, nonsequential characters of the serial number.

9.   An apparatus, comprising:

a body;

a serial number associated with the body, the serial number having a plurality of order characters and a plurality of unique characters;

a plurality of machine-readable, two-dimensional array codes on the body, each encoding a portion of the serial number such that the entire serial number is encoded on the body; and wherein

a first one of the array codes encodes a first one of the order characters, a second one of the array codes encodes a second one of the order characters, a third one of the array codes encodes a third one of the order characters, and the unique characters are sequentially divided among and encoded by the array codes following said ones of the order characters.

10.   The apparatus of claim 9 wherein the serial number is also located on the body in human-readable form.

11.   The apparatus of claim 9 wherein the body has an axis and the array codes are equidistant from the axis.

12. The apparatus of claim 9 wherein the array codes are laser etched on the body.

13. The apparatus of claim 9 wherein each of the array codes comprises a 10x10 array of cells.

14. The apparatus of claim 9 wherein the serial number has three order characters and six unique characters, and wherein there are three array codes on the body, each encoding three, nonsequential characters of the serial number.

15. A method for encoding the serial number of an apparatus, the serial number having a plurality of order characters and a plurality of unique characters, the method comprising:

(a) providing the apparatus with a plurality of machine-readable codes;

(b) encoding one of the order characters of the serial number with each of the codes; and then

(c) dividing and encoding the unique characters of the serial number among the codes following the order characters encoded in step (b).

16. The method of claim 15, further comprising the steps of reading the codes with a machine code reader and reconstructing the serial number to verify its accuracy.

17. The method of claim 15, further comprising the step of forming the serial number on the apparatus in human-readable code.

18. The method of claim 15 wherein steps (b) and (c) comprise independently and sequentially dividing the order characters and the unique characters among the codes.

19. The method of claim 15, further comprising the step of laser etching the codes on the apparatus.

20. The method of claim 15 wherein step (a) comprises providing three codes on the apparatus, each encoding three, nonsequential characters of the serial number.

21. A method for encoding the serial number of an apparatus, the serial number having a plurality of order characters and a plurality of unique characters, the method comprising:

(a) providing the apparatus with a plurality of machine-readable, two-dimensional array codes;

(b) sequentially encoding one of the order characters of the serial number with each of the array codes; and then

(c) sequentially dividing and encoding the unique characters of the serial number among the array codes following the order characters encoded in step (b).

22. The method of claim 21, further comprising the steps of reading the array codes with a machine code reader and reconstructing the serial number to verify its accuracy.

23. The method of claim 21, further comprising the step of forming the serial number on the apparatus in human-readable code.

24. The method of claim 21, further comprising the step of laser etching the array codes on the apparatus.

1   25. The method of claim 21 wherein step (a) comprises

2   providing three codes on the apparatus, each encoding three,

3   nonsequential characters of the serial number.

ABSTRACT OF THE INVENTION

INTERLEAVED SEQUENCING METHOD FOR MULTIPLE TWO-DIMENSIONAL SCANNING CODES

A component has three, laser etched, two-dimensional arrays that each contain three characters of its nine character, alphanumeric serial number. In order for this concept to work, the first three characters of the serial number must be constant for all parts of this type. As a result, the serial number can be divided among the arrays by using the first character as the first digit in the first array, the second character as the first digit in the second array, and the third character as the first digit in the third array. The remaining characters of the serial number are interleaved in the arrays in the following pattern: the fourth and fifth characters are the second and third digits in the first array, the sixth and seventh characters are the second and third digits in the second array, and the eighth and ninth characters are the second and third digits in the third array. With this system, the correct sequence for the arrays will always be ascertainable regardless of the order in which they are read. This concept is useful to maximize

the readability of the serial number in the presence of
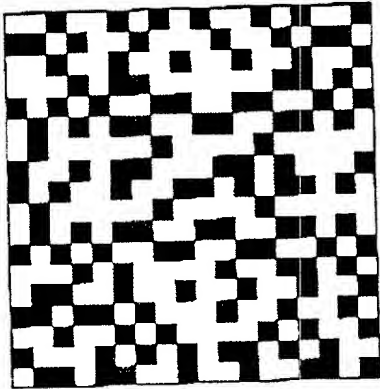
dirt, scratches, and contamination.

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Fig. 1

Fig. 2

19

11

X Y Z 1 A 2 B 3 C

XYZ

1A2

B3C

13

15

17

Fig. 3

21

29

X Y Z 1 A 2 B 3 C

X1A

Y2B
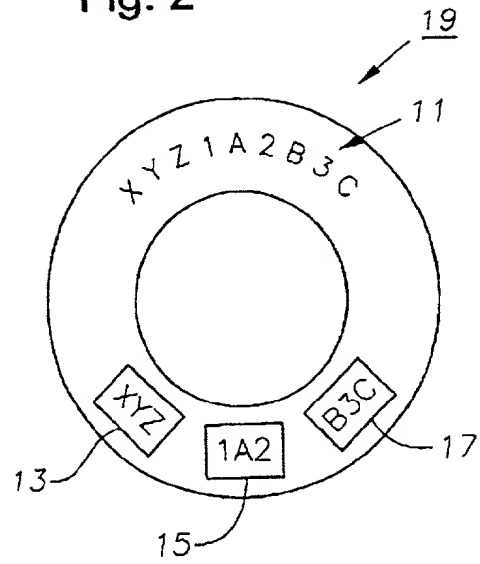
Z3C

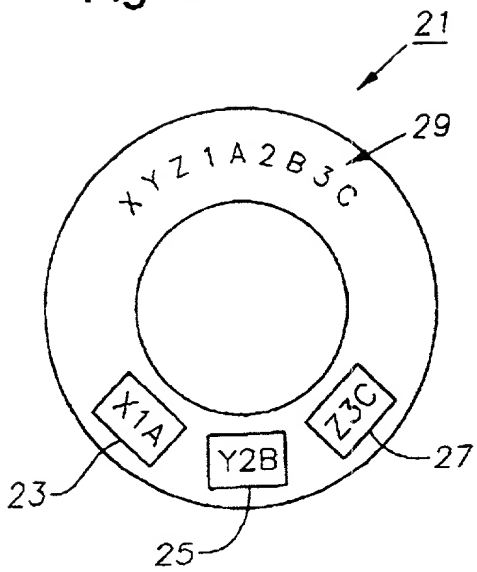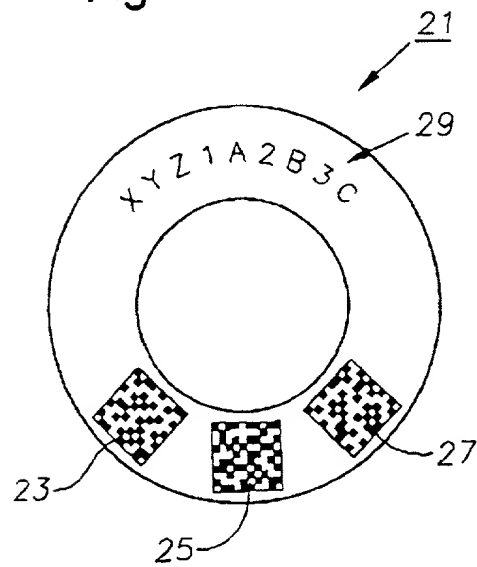23

25

27

Fig. 4

21

29

X Y Z 1 A 2 B 3 C

23

25

27

DECLARATION AND POWER OF ATTORNEY FOR
PATENT APPLICATION

As a below named inventors, we hereby declare that:

Our residence, post office address and citizenship are as stated below next to our names;

We believe we are the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

INTERLEAVED SEQUENCING METHOD FOR
MULTIPLE TWO-DIMENSIONAL SCANNING CODES

the specification of which (check one)

_X_ is attached hereto.

___ was filed on _____
   as Application Serial No. _____
   and was amended on _____
                     (if applicable)

We hereby state that we have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

We acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

We hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s):   Priority Claimed

                                                          ___ Yes___ No
_____ _____ _____
  (Number)   (Country)   (Day/Month/Year)

We hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, we acknowledge the duty to disclose information material to the patentability of this application as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

_____ _____ _____
(Application Serial #)   (Filing Date)   (Status)

We hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As named inventors, we hereby appoint the following attorneys and/or agents to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

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